What is claimed is:

1. An electrochemical fuel cell comprising first and second monolithic electrically conducting flow field-bipolar plate assemblies arranged essentially parallel to each other such that an inside surface of the first flow field-bipolar plate assembly is facing an inside surface of the second flow field-bipolar plate assembly, wherein the flow field-bipolar plate assemblies are electrically and mechanically connected by intervening layers, the intervening layers comprising:

a first electrically conducting intermediate layer bonded directly to the inside surface of the first flow field-bipolar plate assembly,

a second electrically conducting intermediate layer bonded directly to the inside surface of the second flow field-bipolar plate assembly,

a first electrode bonded directly to the inside surface of the first electrically conducting intermediate layer,

a second electrode bonded directly to the inside surface of the second electrically conducting intermediate layer, and

a polymer electrolyte membrane between and bonded directly to both of the electrodes.

2. The electrochemical fuel cell of claim 1, wherein the monolithic flow field-bipolar plate assemblies comprise a first and second porous metal flow field directly bonded to opposite sides of an electrically conducting gas barrier by continuous metallurgical bonds.

3. The electrochemical fuel cell of claim 2, wherein the porous metal flow fields are directly bonded to the electrically conducting gas barrier by electroplating or sintering.

4. The electrochemical fuel cell of claim 2, wherein the electrically conducting gas barrier comprises a metal foil.

5. The electrochemical fuel cell of claim 2, wherein at least one porous metal flow field comprises a three-dimensional reticulated metal structure.

6. The electrochemical fuel cell of claim 2, wherein at least one porous metal flow field further comprises a protecting layer disposed on at least one surface thereof.

7. The electrochemical fuel cell of claim 6, wherein the protecting layer comprises a metal or a metal oxide.

8. The electrochemical fuel cell of claim 7, wherein the protecting layer is a continuous layer of tin oxide.

9. The electrochemical fuel cell of claim 1, wherein the intermediate layer comprises a polymer and high surface area carbon particles.

10. The electrochemical fuel cell of claim 9, wherein the polymer comprises polytetrafluoroethylene, perfluoroethylene-perfluoropropylene copolymer, perfluoro-alkoxy, or polyvanilidene fluoride.

11. The electrochemical fuel cell of claim 1, wherein the electrode comprises a polymer electrolyte and an electrocatalyst.

12. The electrochemical fuel cell of claim 1, wherein at least one of the flow field-bipolar plate assemblies comprises a first metal flow field directly bonded to the

outside surface of an electrically conducting gas impermeable barrier, a second porous metal flow field directly bonded to the outside surface of a second electrically conducting gas impermeable barrier, and a porous metal cooling field disposed between and directly bonded to the inside surfaces of the first and second gas impermeable barriers.

13. An electrochemical fuel cell stack comprising two electrically conducting end-plates and a plurality of electrochemical fuel cells disposed between the endplates, wherein the electrochemical fuel cells comprise first and second monolithic electrically conducting flow field-bipolar plate assemblies arranged essentially parallel to each other such that an inside surface of the first flow field-bipolar plate assembly is facing an inside surface of the second flow field-bipolar plate assembly, wherein the flow field-bipolar plate assemblies are electrically and mechanically connected by intervening layers, the intervening layers comprising:

a first electrically conducting intermediate layer bonded directly to the inside surface of the first flow field-bipolar plate assembly,

a second electrically conducting intermediate layer bonded directly to the inside surface of the second flow field-bipolar plate assembly,

a first electrode bonded directly to the inside surface of the first electrically conducting intermediate layer,

a second electrode bonded directly to the inside surface of the second electrically conducting intermediate layer, and

a polymer electrolyte membrane between and bonded directly to both of the electrodes.

14. A method of making a fuel cell stack comprising disposing between two electrically conducting endplates a plurality of electrochemical fuel cells, wherein the electrochemical fuel cells comprise first and second monolithic electrically conducting

flow field-bipolar plate assemblies arranged essentially parallel to each other such that an inside surface of the first flow field-bipolar plate assembly is facing an inside surface of the second flow field-bipolar plate assembly, wherein the flow field-bipolar plate assemblies are electrically and mechanically connected by intervening layers, the intervening layers comprising:

a first electrically conducting intermediate layer bonded directly to the inside surface of the first flow field-bipolar plate assembly,

a second electrically conducting intermediate layer bonded directly to the inside surface of the second flow field-bipolar plate assembly,

a first electrode bonded directly to the inside surface of the first electrically conducting intermediate layer,

a second electrode bonded directly to the inside surface of the second electrically conducting intermediate layer, and

a polymer electrolyte membrane disposed between and bonded directly to both of the electrodes.

15. A method of generating electrical power comprising supplying hydrogen and oxygen to an electrochemical fuel cell stack,

wherein the electrochemical fuel cell stack comprises two electrically conducting end-plates and a plurality of electrochemical fuel cells disposed between the endplates; wherein the electrochemical fuel cells comprise first and second monolithic electrically conducting flow field-bipolar plate assemblies arranged essentially parallel to each other such that an inside surface of the first flow field-bipolar plate assembly is facing an inside surface of the second flow field-bipolar plate assembly, wherein the flow field-bipolar plates assemblies are electrically and mechanically connected by intervening layers, the intervening layers comprising:

a first electrically conducting intermediate layer bonded directly to the inside surface of the first flow field-bipolar plate assembly,

a second electrically conducting intermediate layer bonded directly to the inside surface of the second flow field-bipolar plate assembly,

a first electrode bonded directly to the inside surface of the first electrically conducting intermediate layer,

a second electrode bonded directly to the inside surface of the second electrically conducting intermediate layer, and

a polymer electrolyte membrane between and bonded directly to both of the electrodes.

16. An air cooled condenser for use with a fuel cell stack, the condenser comprising a three-dimensionally reticulated porous metal condensing element and a three-dimensionally reticulated porous metal cooling element, wherein the three-dimensionally reticulated porous metal condensing element is disposed between two gas impermeable barriers by continuous metallurgical bonds, and wherein the three dimensionally reticulated porous metal cooling element is disposed between and bonded directly to two other gas impermeable barriers.

17. A condenser according to claim 16, wherein the condensing element comprises copper, nickel, aluminum, titanium, or an aluminum-titanium alloy.

18. A condenser according to claim 17, wherein the condensing element comprises nickel.

19. A condenser according to claim 16, wherein the gas impermeable barriers comprise a metal foil.

20. A condenser according to claim 19, wherein the metal foil is tin, copper nickel, aluminum, gold, or an aluminum-titanium alloy.

21. A condenser according to claim 20, wherein the metal foil is nickel.

22. A condenser according to claim 16, wherein the condensing element is bonded to the gas impermeable barriers by electroplating or sintering.

23. A condenser according to claim 18, wherein the cooling element comprises copper, nickel, aluminum titanium, or an aluminum-titanium alloy.

24. A condenser ~~according~~ to claim 26, wherein the cooling element comprises copper.

25. An evaporatively cooled internally humidified fuel cell stack comprising a plurality of fuel cells and an air cooled condenser in fluid communication with the fuel cells,

wherein the condenser comprises a plurality of three dimensionally reticulated porous metal condensing elements and a plurality of three dimensionally reticulated porous metal cooling elements, wherein the three dimensionally reticulated porous metal condensing elements are disposed between and bonded to two gas impermeable barriers by continuous metallurgical bonds, and wherein the three dimensionally reticulated porous metal cooling elements are disposed between and bonded directly to two other gas impermeable barriers.

26. A method of cooling an electrochemical fuel cell comprising placing the electrochemical fuel cell in fluid communication with an air cooled condenser wherein the air cooled condenser comprises a plurality of three dimensionally reticulated porous metal condensing elements and a plurality of three dimensionally reticulated porous metal cooling elements, wherein the three dimensionally reticulated porous metal condensing elements are disposed between and bonded to two gas impermeable barriers by continuous metallurgical bonds, and wherein the three dimensionally reticulated porous metal cooling elements are disposed between and bonded directly to two other gas impermeable barriers.

27. A flow field-bipolar plate assembly for an electrochemical cell, comprising a first and second three dimensional reticulated porous metal flow-fields bonded directly to opposite sides of an electrically conducting gas impermeable barrier by continuous metallurgical bonds.

28. The component of claim 27, wherein the porous metal flow-fields are bonded to the conducting gas impermeable barrier by electroplating or sintering.

29. The component of claim 27, wherein the electrically conducting gas impermeable barrier comprises a metal foil.

30. The component of claim 29, wherein the metal foil is tin, copper, nickel, aluminum, titanium, gold, or an aluminum-titanium alloy.

31. The component of claim 30, wherein the metal foil is nickel.

32. The component of claim 27, wherein at least one flow field comprises tin, copper, nickel, aluminum, titanium, gold, or an aluminum-titanium alloy.

33. The component of claim 32, wherein at least one flow fields comprises nickel.

34. The component of claim 27, wherein at least one of the porous metal flow-fields further comprises a protecting layer disposed on at least one surface thereof.

35. The component of claim 34, wherein the protecting layer comprises a metal or a metal oxide.

36. The component of claim 35, wherein the protecting layer comprise tin, copper, nickel, aluminum, titanium, or gold.

37. The component of claim 35, wherein the protecting layer comprises ruthenium oxide, titanium oxide, or tin oxide.

38. The component of claim 37, wherein the protecting layer comprises tin oxide.

39. The component of claim 34, wherein the tin oxide layer is between about 1 and about 5 μm thick.

40. The component of claim 39, wherein the tin oxide layer is between about 1 and about 2 μm thick.

41. A method of delivering a gas to a fuel cell electrode comprising:

delivering the gas to a porous metal flow field-bipolar plate assembly wherein the porous metal flow field-bipolar plate assembly comprises an electrically conducting gas barrier and a three-dimensionally reticulated porous metal flow field bonded one side of the electrically conducting gas barrier by a continuous metallurgical bond;

wherein the gas contacts the three-dimensionally reticulated porous metal flow field and diffuses into contact with an electrode that is in gas communication with the three dimensionally reticulated porous metal flow-field.

42. The method of claim 41, wherein the porous metal flow field is bonded to the conducting gas barrier by electroplating or scintering.